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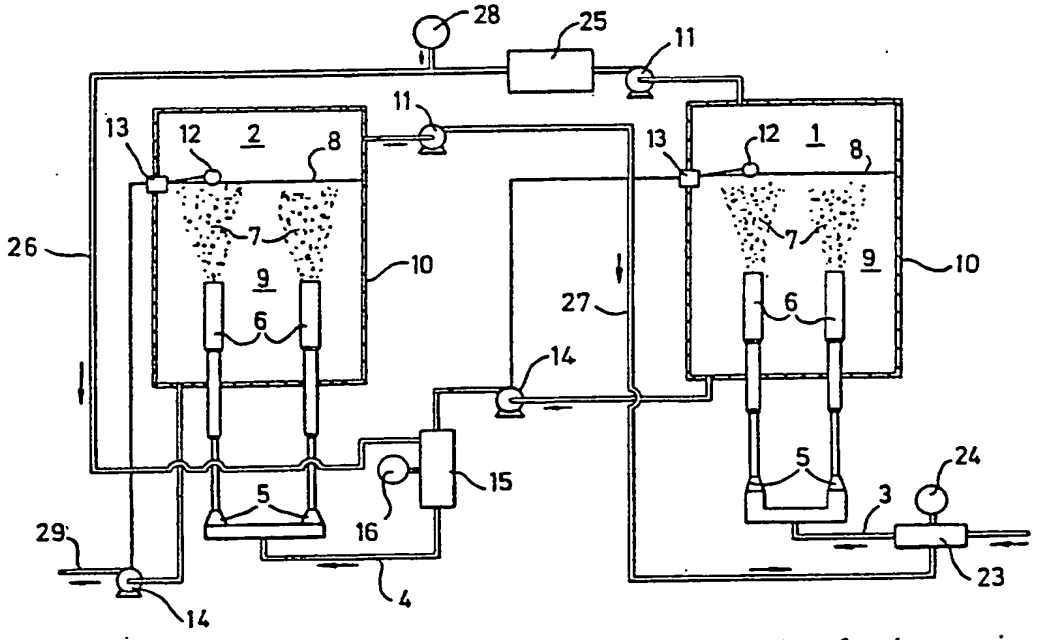
(54) Title: A METHOD OF EXTRACTING GAS FROM LIQUID

(57) Abstract

A method for extracting gas from a liquid employing gas-from-liquid desorbers (1, 2, 17) in which an unwanted gas can be extracted from a liquid after depressurisation therein of the liquid fed to the desorbers at pressure through supply lines (3, 4). The gas desorbers are preferably arranged to form a two stage extraction process, although a single or multi-stage process can be envisaged, such that in a first desorber (1) inwanted gas is extracted from the liquid and the liquid with the thus reduced amount of unwanted gas is fed to a second desorber (2) for further extraction of unwanted gas. Before depressurisation in the desorber (1) additional gas is dissolved in the pressurised liquid passing through chamber (23) so that after depressurisation in desorber (1) dissolved additional gas is desorbed from the liquid, and at the same time unwanted gas is also stripped from the liquid to be replaced by additional gas. Thereafter the liquid with a reduced amount of unwanted gas, is fed under pressure to the second desorber (2) through chamber (15) being supplied with additional gas, and the process of extracting further unwanted gas from the liquid in the desorber (2) is repeated. The method described results in the advantages of more efficient extraction of inwanted gas and reduction of excessive consumption of the additional gas.



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A method of extracting gas from liquid

Technical field of invention

The invention relates to a method of extracting unwanted gas from a liquid and has particular application in extracting dissolved air from sea water which is to be pumped into oil wells drilled in the sea bed.

Background art

During extraction of oil from oil wells drilled in the sea bed, the yield can be increased by forcing sea water into the well to occupy the space formerly occupied by gas and oil. However, unless oxygen dissolved in the sea water is reduced to levels of 0.05 parts per million and less, blockage of the reservoir media can occur due to biological growths. However, great difficulty is experienced in removing the required amount of dissolved air from sea water, particularly at the low temperatures which prevail around offshore oil rigs.

Dissolved gas can be removed from a liquid by adding chemicals which react with the gas. However, this method is normally quite expensive due to difficulties in the transportation and handling of these chemicals when used in offshore systems.

Another technique is to heat the liquid, preferably to its boiling point. This usually involves excessive energy consumption and, in at least some cases, the liquid must be cooled before it can be used.

Because of these difficulties, degassing of liquid is frequently carried out by mechanical means using a desorption device, such as that disclosed in UK Patent Specification No. 1 461 591, where the liquid is subjected to very low pressures. However, in order to remove sufficient dissolved air from sea water to reduce the oxygen level to one part per million it is necessary to adopt a multi-stage process and very low pressure. This requires complex equipment and high expenditure of energy and, in practice, is of limited

effectiveness. Thus, when removing dissolved air from sea water, this method is not capable of conveniently reducing the oxygen content to the low levels required.

Another method of extracting unwanted gas from a liquid comprises the steps of depressurising the liquid and then passing additional gas through the liquid so as to bring the liquid into intimate contact with the additional gas. However, this method also requires multi-stages, and good gas-liquid contact if excessive consumption of additional gas is to be avoided.

Disclosure of the invention

It is intended, by means of the present invention, to provide a method of passing additional gas through a liquid to extract unwanted dissolved gas in a manner which avoids the former disadvantages of this method, particularly the excessive consumption of additional gas.

This purpose is achieved by first pressurising the liquid containing the unwanted gas, and adding additional gas to the liquid all or part of which is dissolved in the liquid, and then depressurising the liquid so that on desorption of at least part of the additional gas, at least part of the original gas is also stripped from the liquid.

Thus, according to the invention, there is provided a method of extracting unwanted gas from a liquid comprising the steps of pressurising the liquid and dissolving additional gas in the pressurised liquid, and then depressurising the liquid so that on desorption of at least part of the additional gas, at least part of the original gas is also stripped from the liquid.

The additional gas may be of different composition to the unwanted gas and chosen so that, where the unwanted gas is chemically unacceptable, any residual additional gas will be chemically acceptable. Thus, where the unwanted gas is oxygen, because it is desired to avoid oxidation of material which comes into contact with

the liquid, the additional gas can be non-oxidising gas such as nitrogen or a hydrocarbon gas.

To reduce the volume of additional gas used in this operation all or part of this gas may be recycled, and all or part of the recycled gas may be passed through a catalytic burner which will remove the unwanted gas from the recycled stream.

Two methods embodying the invention are hereinafter described, by way of example, with reference to the accompanying drawings.

Brief description of the drawings

Figure 1 is a schematic arrangement of preferred apparatus for carrying out the invention, incorporating two gas desorbers as disclosed in UK Patent Specification No. 1 461 591,

Figure 2 is a schematic arrangement of apparatus similar to that shown in Figure 1, but employing only one gas desorber as disclosed in UK Patent Specification No. 1 461 591, and

Figure 3 is a schematic arrangement of a further apparatus for carrying out the invention in a two stage process.

Exemplary modes of carrying out the invention

In the apparatus shown in Figure 1, first and second gas desorbers 1 and 2 have inlet pipes 3 and 4, respectively. Each inlet pipe is connected to two nozzles 5 which each has a convergent orifice connected to a four-part desorption tube 6. As shown, the cross-section of desorption tube 6 increases abruptly between its adjacent parts.

Pressurised liquid fed through the inlet pipes 3 and 4 issues from the nozzles 5 in the form of divergent jets and, as a result of the reduction in pressure in these jets, at each abrupt change in cross-section of the desorption tube 6, dissolved gas comes out of solution and forms bubbles 7.

These bubbles rise to the surface 8 of liquid 9 contained in receptacles 10 and is removed by vacuum suction pumps 11. A float 12 operates an actuator 13 when the liquid surface 8 reaches a predetermined level and the actuator 13 then causes operation of liquid extraction pump 14.

The liquid extraction pump 14 of the first device 1 discharges liquid containing a small amount of dissolved gas at pressure into chamber 15. Additional gas from tank 16 is also fed into the chamber 15 so as to dissolve in the liquid. This liquid is then fed through inlet pipe 4 into the second gas desorber 2 where the process of gas desorption is repeated and, as a result, at least part of the gas remaining in the liquid fed to the chamber 15 is withdrawn from the liquid with at least part of the additional gas from tank 16.

In practice, when removing dissolved air from cold sea water, sea water having about ten parts per million of dissolved oxygen is fed into inlet pipe 3 at the rate of 100 thousand gallons per hour. The level of dissolved oxygen in the liquid 9 in the receptacle 10 of the first desorber 1 may be reduced to one part per million and this is fed by liquid extraction pump 14, at a pressure of 3 Bars into the chamber 15. Pressurised nitrogen is then fed from tank 16 into chamber 15 so as to ensure that the nitrogen is dissolved in the liquid. The liquid with the dissolved nitrogen is then passed through the second desorber 2 which could be at or above atmospheric pressure in order to prevent ingress of further air, so as to maintain the low level of dissolved oxygen. The receptacle 10 of the second desorber 2 can therefore also act as a sea water storage vessel for supplying the high pressure injection pump necessary to force the sea water into the oil well. In this manner, the level of dissolved oxygen in the liquid 9 of the second desorber 2 may be reduced to one hundred parts per billion before it is removed by the pump 14. Although, in this embodiment, the additional gas was nitrogen, another non-oxidising gas, such as hydrocarbon gas, could be used.

Although this preferred mode of carrying out the invention involves the use of two gas desorbers as disclosed in UK Patent Specification No. 1 461 591, it is to be understood that either or both of the first and second desorbers could be replaced by a desorption apparatus of different design.

Thus, as shown in Figure 2, the second desorber 2 of the apparatus shown in Figure 1 has been replaced by a simple discharge device 17 having a pressure reduction valve 18 at the discharged end of the inlet pipe 4 from the chamber 15. Liquid 19 in receptacle 20 of the discharge device 17 is free of the dissolved gas which escapes in the form of bubbles 21 and this liquid can be withdrawn from the receptacle 20 through valve 22.

The apparatus of Figure 3 is similar to the apparatus of Figure 1 (and therefore where similarity exists identical reference numerals have been used) but modified so that the extraction of unwanted gas from the pressurised liquid takes place in two stages. Moreover the apparatus of Figure 3 also utilises the advantages of recycling any undissolved additional gas in the gas desorbers 1 and 2, thus providing economies when a sparingly soluble gas such as nitrogen is used.

In Figure 3 raw pressurised liquid in the inlet pipe 3, instead of being passed directly to the nozzles 5 as in the Figure 1 embodiment, enters a chamber 23 into which additional gas from a tank 24 is fed to dissolve in the liquid. The pressurised liquid with the additional gas is then fed to the nozzles 5 of the first device 1, where the process of gas desorption takes place and as a result, at least part of the unwanted gas is withdrawn from the liquid and comes off as bubbles 7 together with any undissolved additional gas.

The gases from the first gas desorber device 1 are extracted by the vacuum suction pump 11 as before, but instead of being delivered to atmosphere they are passed through a catalytic burner 25 to clean off the unwanted gas. The purified gas now in the form of the additional

gas, is delivered to the chamber 15 in the inlet pipe 4 through delivery pipe 26 to combine with the additional gas being fed into that chamber 15 from tank 16 for subsequent delivery with the pressurised liquid from extraction pump 14, to the nozzles 5 of the second gas desorber device 2.

Further unwanted gas in the liquid is extracted in the second device 2 to form bubbles 7 both of unwanted gas in minute quantities and undissolved additional gas. These gases are then removed from the device 2 by vacuum suction pump 11 and passed through delivery pipe 27 to the chamber 23 which receives primary additional gas from tank 24. Any loss of additional gas due to absorption into the liquid during operation of the system may be replenished by additional gas from a make-up tank 28 feeding into delivery pipe 26 downstream of the catalytic burner 25.

In practice when removing dissolved air from cold sea water, sea water having about ten parts per million of dissolved oxygen is fed into inlet pipe 3 at a rate of 450 cm per hour. The level of dissolved oxygen in the liquid 9 in the receptacle 10 of the first device 1 may be reduced to one part per million, and this is fed into the second device 2 where the oxygen content may be reduced further to one hundred part per billion at the outlet 29 from the second gas desorber 2. In this application the flow rate of nitrogen in the system would be 450 cm per hour at standard temperature and pressure, recycled continuously through the catalytic burner 25.

In this embodiment both devices 1 and 2 are operated at atmospheric pressure but an alternative arrangement would have device 1 operating at a higher pressure than device 2 so that the liquid extraction pump 14 and the pump 11 in delivery pipe 26, would not be needed.

CLAIMS

1. A method of extracting unwanted gas from a liquid comprising the steps of pressurising the liquid containing an unwanted gas, dissolving additional gas in the pressurised liquid, and depressurising the liquid so that on desorption of at least part of the additional gas, at least part of the unwanted gas is also stripped from the liquid.

2. A method as claimed in Claim 1 wherein prior to dissolving the additional gas in the liquid, the liquid is initially depressurised so that part of the unwanted gas is desorped from the liquid.

3. A method as claimed in Claim 1 wherein pressurisation of the liquid occurs in two stages, additional gas being dissolved in the liquid before depressurisation in each stage, and wherein any additional gas undissolved after first and second stage depressurisation is recovered and dissolved in the pressurised liquid before depressurisation in the second and first stage respectively.

4. A method as claimed in Claim 3 wherein any additional undissolved gas recovered after depressurisation in the first stage is catalytically burned to remove traces of unwanted gas not stripped from the liquid in said first stage.

5. A method as claimed in any preceding claim wherein the additional gas is of a different composition than the unwanted gas

and chosen so that where the unwanted gas is chemically unacceptable, any residual additional gas in the liquid will be chemically acceptable.

6. A method as claimed in Claim 5 wherein the liquid is sea water, the unwanted gas is oxygen and the additional gas is nitrogen.

7. Apparatus for removing unwanted gas from a liquid comprising gas-from-liquid desorption means (1,2,17) for removing at least part of an unwanted gas from pressurised liquid delivered thereto characterised in the provision of means (15,16,23,24) for supplying additional gas different from said unwanted gas to the pressurised liquid entering said gas-from-liquid desorption means (1,2,17), so that on desorption of at least part of the additional gas from the liquid therein, at least part of the unwanted gas is also stripped from the liquid.

8. Apparatus as claimed in Claim 7 wherein said gas-from-liquid desorption means comprises a first gas-from-liquid desorber (1) for extracting unwanted gas from the liquid, a second gas-from-liquid desorber (2) for extracting further unwanted gas from the liquid, a first supply line (3) for delivering pressurised liquid to said first desorber (1), a second supply line (4) for delivering pressurised liquid from which said at least part of the unwanted gas has been removed, to said second desorber (2) for further extraction of unwanted gas, a first supply means for supplying additional gas (23,24) to said first supply line (3), and a second supply means (15,16) for supplying additional gas to said second supply line (4).

9. Apparatus as claimed in Claim 8 wherein a catalytic burner (25) is provided for removing unwanted gas from recovered additional gas not dissolved in the liquid in said first desorber (1), a third supply line (26) for delivering such cleaned recovered additional gas to said second supply means (15,16), and a fourth supply line (27) for delivering undissolved additional gas recovered at said second desorber (2) to said first supply means (23,24).

10. Apparatus as claimed in Claims 8 or 9 wherein a separate supply (28) is provided for delivering additional gas to said third supply line (3) downstream of said catalytic burner (25) as make-up additional gas for losses of additional gas dissolved in said liquid.

11. Apparatus as claimed in Claim 10 wherein the liquid is sea water,. the unwanted gas is oxygen, and said additional gas is nitrogen.

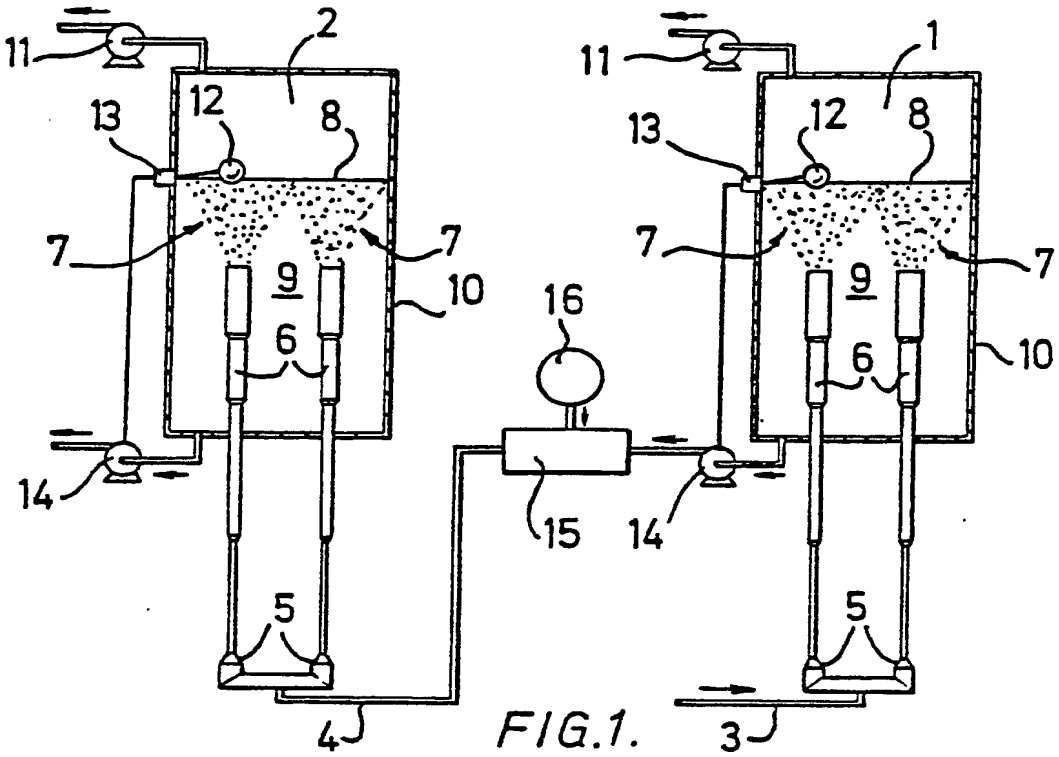

FIG.1.

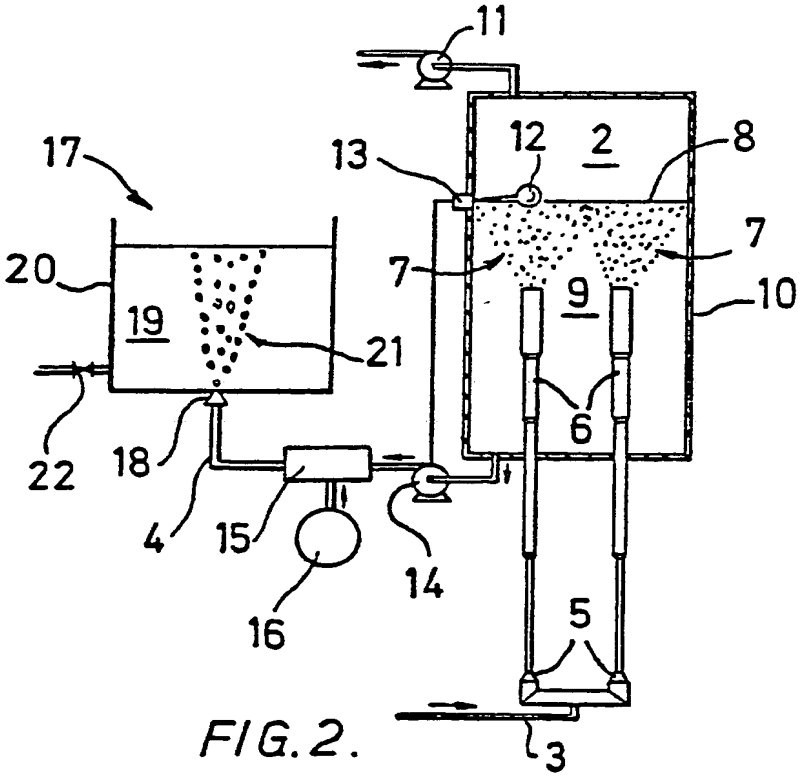

FIG.2.

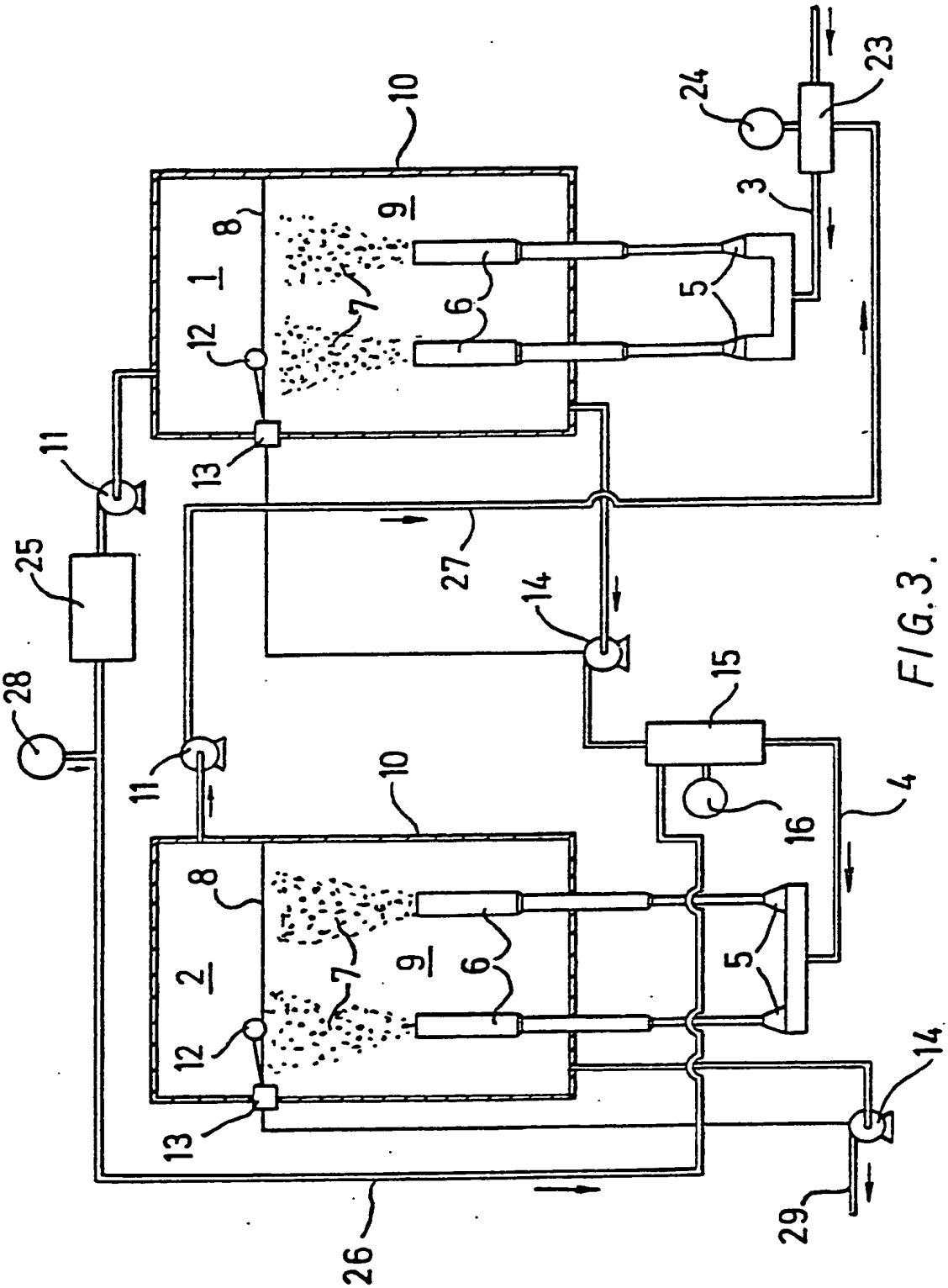

FIG.3.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 83/00005

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[3]: B 01 D 19/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC[3]	B 01 D; C 02 F

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	GB, A, 1531537 (BRITISH PETROLEUM) 8 November 1978 see page 1, lines 9-16, 54-63; line 81 - page 2, line 70; claims 1-5; figures	1,3-8,10,11
X	US, A, 3815330 (C.M. LAWLEY) 11 June 1974 see column 2, line 30 - column 4, line 65; figure 1	1,3,5,6-8, 11
X	US, A, 4259360 (J.M. VENETUCCI) 31 March 1981 see column 1, lines 41-60; column 2, lines 12-40; column 3, line 56 - column 4, line 15; figure 1	1,5-7,11
A	US, A, 1762432 (M.J. TRUMBLE) 10 June 1930 see page 1, line 97 - page 2, line 88; claims; figure	1,2
A	FR, A, 2345397 (BROWN, BOVERI & CIE.) 21 October 1977 see page 2, lines 1-8 ./.	4

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IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
21 April 1983	03 MAI 1983
International Searching Authority [1]	**Signature of Authorized Officer [20]**
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

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III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category *	Citation of Document, 16 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No 18
A	GB, A, 1461591 (BRITISH HYDROMECANICS RESEARCH ASSOCIATION) 13 January 1977 cited in the application	